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How can we increase our professional and technical manpower resources to fill growing future demands?

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Eleven leading Canadians discuss the problem.

DEPARTMENT OF LABOUR • CANADA

PRICE 10c.

The speeches contained in this booklet constituted a special 11-week series of broadcasts on the "CANADA AT WORK" radio program, which is produced by the Information Branch of the Department of Labour in Ottawa, and is heard each week in the year over 70 independent stations across Canada.

FOREWORD

During the past two years industry, government and educational leaders have become more and more concerned with the problem of meeting the growing long-term demand for highly-trained professional and technical personnel. This concern has intensified during recent months, in view of the importance attached to development of intercontinental missiles and man-made satellites in outer space.

The vital question uppermost in many people's minds during these critical times has been this: is the supply of technicians, engineers and scientists adequate to maintain Canada's technological advances commensurate with the country's future needs?

Out of this basic problem have evolved a number of specific questions. Are we putting our professional manpower to the best possible use? Where do our technicians come from, and where exactly do they fit into the picture? What can industry do to help develop more technical manpower? Are there adequate vocational guidance programs in our schools? Have we enough science and mathematics teachers in our high schools? Are our university training facilities adequate? Just how important is a university degree? What can the technological institutes do to help?

The Department of Labour, in common with other governmental agencies concerned with the supply and demand of technical and professional manpower, has undertaken considerable research on our professional and technical manpower resources. As an important part of this program the department early last summer invited eleven leading Canadian executives from the fields of industry, education, science and government, to express their thoughts on the subject.

Their views on the problem, and their suggestions as to steps which could be taken towards solving it, are found in the speeches printed in this booklet. These men's findings are even more significant and appropriate today, than when they were originally made known nearly a year ago, in the light of recent developments in the world of science and engineering.

Anyone who has an interest in Canada's resources of professional and technical manpower in this critical period of our history, will find much to think about from reading these talks.

A. H. BROWN,
Deputy Minister of Labour.

Ottawa,
March, 1958.

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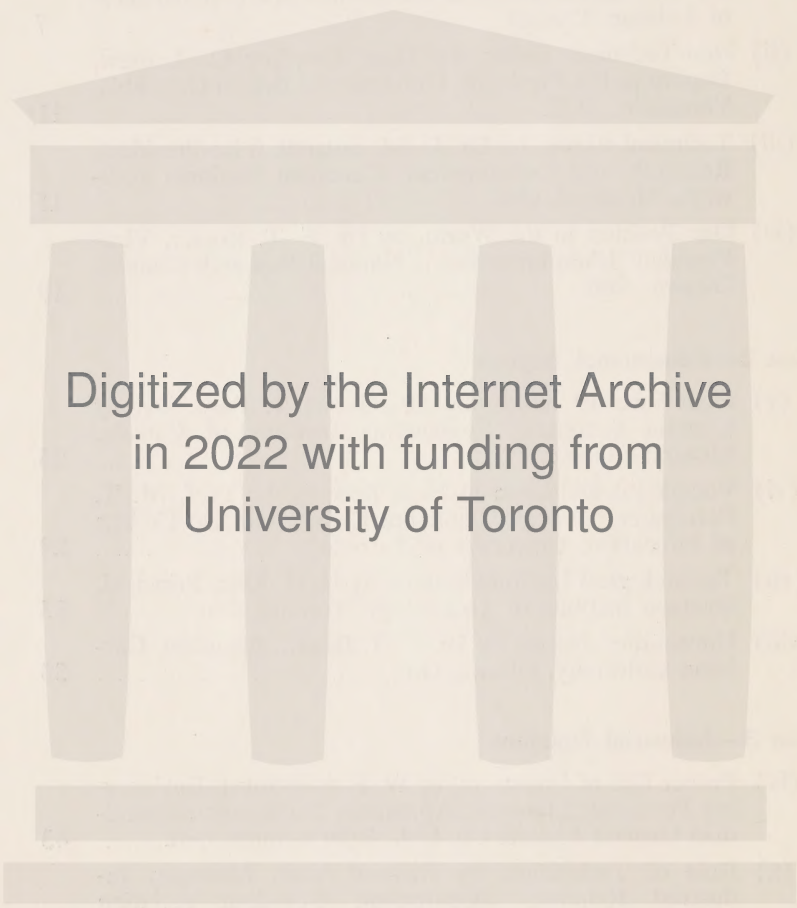

SECTION 1—GENERAL VIEW OF THE PROBLEM

(i) Broad View and Introduction

By Dr. W. R. DYMOND,

Director, Economics and Research Branch, Department of Labour, Canada.

(Editor's Note: In view of the statistical nature of Dr. Dymond's talk, he was invited shortly before this pamphlet went to print, to revise his text which was originally written early last year. The figures quoted are as nearly as possible up to date, consistent with lapse of time during printing and distribution.)

Until a few months ago we heard a good deal about Canada's shortage of professional manpower, and hardly a day passed without some reference to the critical lack of engineers and scientists. Today much of the concern over current and prospective shortages of professional manpower seems to have faded away. This is perhaps rather surprising, because if we still had any doubts about the need for greater effort in a whole range of scientific and engineering fields, such doubts must have been finally dispelled by the dramatic events of recent months.

Perhaps the main reason why the supply of professional manpower no longer seems such a large problem has been the recent levelling off of business activity. Many industries are now going through a period of adjustment. Their expansion is slowing down a bit, and with it the need for increasing their professional staffs at a rate comparable to that of the past few years.

It would be extremely foolish for us to now jump to the conclusion that professional manpower problems no longer exist and, in doing so, if we lost sight of the challenge that lies ahead.

Highly trained professional manpower is and always will be basic to our economic growth and national security. Since it takes many years to train competent engineers, scientists, medical personnel and professionals of virtually every kind, their supply cannot be increased overnight in response to any sudden upsurge in demand. This means that if we act without foresight today we will have a future problem that will not lend itself to a short run solution.

Over the last five or six years many kinds of professional workers have been in short supply. Shortages of engineers and scientists became particularly acute in the last two years. Demand for many other kinds of professional people such as commerce graduates, social scientists, medical personnel, architects and veterinarians, although not quite so insistent, has also been generally greater than available supplies.

What has caused these shortages, and what of the future? One basic factor is that the number of youth in the college age group has remained virtually constant in the last decade. Between 1946 and 1955, for instance, the number of young men and women in Canada between the ages of 18

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and 21 increased by only 3 per cent, while Canada's total population increased by 27 per cent. In the years ahead, however, the size of the college-age group will increase from 900,000 in 1956 to 1,245,000 by 1965. This foreshadows a large increase in the number of youth who will want to go to college.

By 1951 the great majority of veterans among college students had completed their training, and the number of graduations began to fall when the Canadian economy was riding the first post-war wave of expansion. The sharp decline of veteran enrolment was reflected in the number of graduations for the next five years. From 1951 to 1956 the number of students graduating from Canadian colleges and universities diminished each year. This downward trend was not reversed until last year, and the annual total may now be expected to rise each year as the larger number in the college age group embark on university training.

In 1956, when graduations reached their lowest point in nearly a decade, the Canadian economy was in the second consecutive year of a record expansion. It was in that year—1956—that the shortages of professional manpower were particularly acute.

In the last two or three years the demand for engineers, as reported by prospective employers, has actually exceeded the *total* new supply, which, of course, includes not only each new graduating class, but also the net gain from immigration after allowing for losses due to emigration. In 1956, for instance, the total new addition to our pool of engineers amounted to approximately 2,500 of whom some 1,600 were new graduates from Canadian universities and the remainder—900—represented the balance in favor of immigration over emigration. In that same year—a year when shortages were most acute—employers reported that they could use more than 3,000 new graduates.

The number of new engineers who graduated in 1957 was not very much larger than the class of 1956, but the net gain from immigration was about twice as large as in the previous year. The large inflow of immigrants last year has certainly contributed much to the current easing of the pressure on the market for engineers.

Professionals are an ever increasing proportion of the labour force which itself is growing. In 1931 professionals made up 4.8 per cent of the labour force, and in 1956 they made up about 6.2 per cent. This means that, with a growing labour force, the number of professional workers increased by nearly 80 per cent in a twenty-five year period. It is estimated that there were about 340,000 professional workers in Canada in 1955. If the past growth trends continue in the future, we shall need at least 470,000 professional workers by 1965, nearly 40 per cent more than in 1955. For some kinds of professional workers, the rate of increase in requirements will be even higher than 40 per cent.

Such figures, of course, can at best be only informed guesses, but they are by no means unrealistic. The increasing technological complexity of industry is sure, in the long run, to result in an ever increasing demand for technically trained people. Moreover, as our standard of living increases, an increasing proportion of our income will be allocated to satisfying demands for services in such fields as education, health, culture and recreation. In 1951 the professions concerned with education, health and culture together accounted for more than half of Canada's total number of professional workers. The upward trend of real income per capita in Canada will almost

certainly cause requirements for professional workers of these types to grow more rapidly than the total Canadian population or the total labour force, and probably more rapidly than these requirements have grown in the past.

This, then, is the outlook on the requirements side of the labour market for professional manpower. What is the outlook on the supply side?

It seems likely that in the next eight or ten years our net gain from immigration of persons with professional training will diminish. University graduations, on the other hand, will increase considerably, perhaps to more than 21,000 by 1965, or nearly 9,000 over last year's total.

Such an increase should lessen our reliance on immigration, and still remain adequate to bring our supply of professional manpower more closely into balance with future demand. The great danger, as I see it, is that some of our young people of college calibre, particularly those contemplating a career in engineering or science, might now be tempted to forego academic training under the false impression that the expansion in the demand for such services has come to an end. This is most emphatically not the case, and if young people of ambition fail to realize this and make the wrong choice now, we will once again find ourselves short of professional manpower in the years ahead.

I would like to mention next the question of utilization or mis-utilization of professional manpower, particularly in scientific and in technical fields. With the developing shortage of engineers over the past few years, the matter of mis-utilization of professional talents has raised much concern.

Mis-utilization usually has two facets. The first, where engineers are performing functions which are at the sub-professional level and could be performed by less qualified persons, and the second, the drift of engineers from the strictly technical field to the less-technical or non-technical fields such as sales and administration. While evidence of both types of under-utilization or mis-utilization has been quite widespread throughout Canadian industry, caution must be exercised in any realistic evaluation of this problem.

The employer's attitude or approach towards the employment of engineers must be taken into consideration. If an employer hires a man more for his potential contribution to the firm than for the purpose of performing a specific function at a specific time, then it is probable that at many periods throughout the man's career with the company he will be performing tasks which might be either at the sub-professional level or in the semi or non-technical fields. This could all be part of his training and development towards a more responsible and useful position. Also it is industry's view that it is quite essential for economy and efficiency to have technically professional persons filling some positions which are not strictly technical in nature, such as sales, purchasing, budgetary control and the like.

An important key to the more efficient utilization of professional talent rests on the provision of adequate supplies of trained technicians to assume the sub-professional functions which engineers are presently performing in many cases. Competent technicians usually have to be of high school or technical school calibre because of the background in mathematics and science required. In addition, a fully trained technician needs two to three or more years of specialized training and work experience beyond high school. So far, this growing demand for technicians on the part of industry, government and other employers of technical personnel has been met by immigration and by the development and expansion of such institutions as the Ryerson

Institute in Toronto. Industry is now responding with stepped-up on-the-job training programs. Increased government funds are now being directed towards the expansion and establishment of new training institutions for technicians and technologists.

In conclusion, I would like to turn to some of the problems which surround the training of professional manpower.

A key factor which will hamper the development of adequate supplies of scientists and engineers in future years is the serious shortage of qualified teachers of science and mathematics in the high schools. The mathematics and science teacher provides a seed-bed from which our future scientists and engineers flower. If qualified and interested students are not provided with an adequate background in mathematics and science in high school they are not likely to be equipped to undertake the rigorous training in science and engineering in university. Unless an adequate flow of high school teachers is provided, the very foundation on which much of the development of technical manpower in Canada depends, will be further weakened.

A major problem which Canada faces in increasing the numbers of professionals in future years is the expansion of the facilities of our institutions of higher learning. A great many steps have already been taken in this respect. Some fairly extensive programs of expansion have already been embarked upon by our major universities, while other programs are developing as future needs become more evident.

Throughout this process of physical expansion, which will have to accommodate double our present enrolment within ten years, there must be continued vigilance against any tendency to lower academic standards.

With the fairly general movement towards better utilization of technical manpower in industry, demands for better training, particularly in the areas of research and development, will be placed upon our professional talent.

(ii) Non-Technical Fields

By Dean Geoffrey C. Andrew,
Deputy to the President, University of British Columbia, Vancouver, B.C.

I have been asked to discuss this evening the roles played in Canadian life by men and women in professional fields other than technical, to stress, that is, the importance of the arts and humanities, social sciences and other related professions. This I am very happy to do, for as a university teacher, I have frequently young men and women come to me to discuss their programs of study and their future aims when they are not clear in their own minds that their interests coincide exactly with established professional studies. They may be preparing for a university program leading to engineering, law, or medicine, but they are not sure whether they want to practise engineering, law or medicine. They are interested, perhaps, in some aspects of the practice, but they may also be very much interested in research or administration or politics, or in interpreting the findings of these professions to the public at large. They want, in short, a career that is not entirely professional practice. Sometimes it would appear that the answer is that they should start with professional practice, and branch out into other aspects of their interests as time and opportunity afford. On the other hand, I, like many other people, am conscious of the fact that a great many of the leaders in our national life are people who have prepared themselves consciously or unconsciously for a career which does not fall into any of the professional categories. The fact is that there is in a free society and a free economy such as ours a very considerable freedom to move around within related kinds of work, and this makes possible the use of a general education in a variety of fields of activity. The general education must not, of course, be so general that it does not add up to any body of knowledge, and the person who pursues this kind of education has to be willing to take a chance on finding the job to fit his particular qualifications. Not all the people who pursue this type of education will, of course, end up as leading figures in the national scene. The matter is more one of what gives satisfaction to the individual, than of aiming at a specific career objective.

So far what I have said has been in general terms, but who are these people, what are they trained for and what do they do? A few examples will perhaps illustrate my point. The first is from public life—a man whose career is well known to many Canadians—Lester Pearson. He studied history at university, and according to him, played a lot of baseball. He became a university teacher, joined the Civil Service, entered politics, and has played a distinguished part on the international stage. He has had a career in non-technical fields, based on studies in history.

Another example, from business this time, Dr. A. E. Grauer, President of the British Columbia Electric Company, who studied economics and law, became a professor of the social sciences at Toronto University, before entering the large public utility he is now president of.

Another that I know has had a satisfying career in newspaper work, teaching and politics, all based on a general arts education in the social sciences. The present Deputy Minister of Welfare in the Federal Department of National Health and Welfare, Dr. George Davidson, started off his career as a brilliant student of classics.

One thing all these people have in common is a demonstrated interest in human and social relationships. This is exactly what one would expect from people who have studied the humanities and the social sciences. The study of subjects like history, sociology, economics, philosophy, political science, language and literature, does not, of course, create an interest in human and social problems. People who are primarily interested in human and social problems tend to study such subjects, and the subjects deepen and broaden their understanding of the problems. There are many satisfying careers to be carved out, based on the liberal arts program at the university, and there are many young men and women coming to the university who say to me, in effect, what one young man said recently: "I didn't know what I wanted to do when I finished school, so I went to work. I worked in the woods for seven years and liked the work, but during that time I became more and more anxious to learn more about myself, other people and what they think. I decided to come to university so I enrolled two years ago. The first year was hard slugging because I was rusty, but it was fun. The second year was terrific! I still don't know what I will do—I may go into teaching or personnel work, or social work, but I am not very worried. I am having the time of my life learning, and nobody can take away the joy of learning."

I don't know what this young man will do, and it doesn't matter—what I do know is that whatever he does, he will make a worthwhile contribution to society and will also have the personal resources not to care too much if the world is not as kind as it might be. My own tendency as a university teacher is to advise young people to find out what gives them most satisfaction in their studies, to find out what they do best at, pursue those studies, and then and only then find out how they make a living at what they like to do. This advice will lead a great many people into a clearly defined professional field, technical or otherwise. It will, on the other hand, lead others to study both law and social work, others still, literature and philosophy, or history and anthropology, still others economics and political science. Having studied in these fields, if they have studied successfully, they must then face the working world with skills which do not add up to recognized professional qualifications. They still have to prove that their skills are a marketable commodity, and as a consequence they are likely to be a little later finding their niche in life than those who have worked for a straight professional ticket. Most frequently people with such qualifications gravitate for a time into one or other of what might be called the interpretative professions—those that I have referred to in my case histories—teaching in the university or high school, working on a newspaper, or in radio or television, in the civil service, politics, or other aspects of public affairs, or business and industry, on the human or public relations side. One reason why universities have been slow to develop schools of journalism or schools of communication, or indeed many applied fields of humanistic and social scientific studies, is because there is no general agreement on what kind of academic training best leads to a career within these interpretative professions. Both the requirements and the qualifications are very various. A good

newspaper reporter or a good politician, or for that matter a good high school teacher, should know something of history, economics, philosophy and literature. He should be able to express himself accurately, clearly, and if possible, colourfully. He should in addition have some special field of interest. The rest he can learn on the job. What I call the interpretative professions are to a considerable extent interchangeable. They are also in a very real sense the group that binds society together, that interprets each to other—they are, in fact, our social cement.

This would, however, still seem to be in our society an area in which individual quality is more important than standard qualifications. In addition to these interpretative professions, there are also relatively undefined areas between the recognized professions, the proper education for which is likewise ill-defined. I could refer here to the areas between social theory and law, or social welfare and medicine, or those areas surrounding the social implications of technological change. In such areas there is no package deal in the university curriculum. The individual must still be led by his own curiosity and his own desire to find personal satisfaction in pursuit of an area of study and its application. New professions are only created by social pioneers.

As I have already indicated, a number of our national leaders in business and industry and government and public service, have been social pioneers in the sense that they trusted their native curiosity to lead them to their career objectives.

Original studies in such fields as philosophy, history, classics, have led to shorter or longer periods of service in industry, in government, in teaching, in the military services during the war, and each of these experiences would seem from the progress of the career to have contributed something by way of experience to their qualifications for their present positions.

In the same way, some of the most contented people I have met are those who, if they have not found eminence, have at least found satisfaction in pursuing lines of study and occupations which fall outside the professional field, but which have been providing the individuals concerned with the rewards of individual interest and personal absorption in the work they are doing. These are the people who provide the leadership in most of the voluntary organizations, which are the very essence of a free society.

Today there are very strong social influences tending to make young people feel that they should have decided on their profession by the time they come to university, and the profession should be one clearly recognized because they cannot afford to "shop around", as they say, during the process of their university career. This point seems to me essentially anti-educational. A certain amount of shopping around and a good deal of self-discovery, is an essential prerequisite to an education which means what it should mean in self-fulfilment and self-realization. There are, in short, lots of opportunities in the gaps between the professions, for those who want to focus their education on their own personal intellectual curiosity, and their own sense of social need. It's a commonplace to observe today that we are living in an age of great technological change. It is less frequently noted that we are also living in an age where social and human implications of technological change are equally revolutionary.

Canada in its relatively short life has a remarkable record of achievement in many of the sciences and applied sciences. A good deal of the impetus to scientific development has been provided by the National Research

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Council, by industry, and by government grants in such fields as health and welfare, agriculture, fisheries, etc. This is one of our marks of national distinction. Our first problems as a people, were those of inhabiting a northern continent and learning how to live in it, on conquering the problems of our geographical area and building physical communications. This work is, of course, not in any sense completed, and increasing numbers of people need to be attracted to develop and purchase the gains we have already made.

Other areas of our national life have, however, suffered from relative neglect, and this was a matter of public record, forcibly and vigorously made by the publication of the Massey Report on the Development of the Arts, Letters, Humanities and Social Sciences in Canada.

This year the Federal Government has set up a Canada Council for the encouragement of the Arts, Letters, Humanities and Social Sciences, and it is expected that as a result of this move there will be more money available in the form of scholarships, loans and grants, to encourage young people to risk a career in these areas, and also to provide them with some minimal support such as has been provided to young scientists by the National Research Council Awards.

Quite apart from the encouragement of creative and artistic activity there is at the present time an urgent need for more people to devote themselves to study about the social and human implications of industrial change, the social and human implications of modern systems of communication, and the social and human implications of the shrinking world society. These areas of study are still too new to be regarded as professional studies, though some of the established professions are expanding their offerings to try and embrace some of the more urgent aspects of these studies. Our young people, as anyone who is teaching in the university will be glad to corroborate, are still as willing to accept the challenge to explore new areas of interest and activity as ever they were, provided society at large and the counsellors in schools in particular do not impress on them the need to make up their minds about their future professional activity before they have had a chance to explore these new areas which have not yet become professionalized. To many of our young people the best career advice we can possibly give is "Don't choose a profession, but follow your interest and find your profession".

(iii) Technical Fields

By Dr. O. M. Solandt,
Vice-President, Research and Development,
Canadian National Railways, Montreal, Que.

In concluding this series of talks on the role of the scientist, the engineer and the technician in modern society, I thought that I would try to give you a general picture of the structure of the scientific community in Canada in the hope that contemplation of this picture will tend to unify in your mind all the presentations that have gone before. For this purpose I shall invent some definitions; you don't have to agree with them—just accept them for purposes of this discussion. The first is that science is a body of knowledge which contains the accumulated and organized results of man's observations of, and thinking about, the physical world. The second is that a scientist is anyone whose days are mainly occupied in making direct use of a part of this body of knowledge. This is obviously an unconventional definition of a scientist, but I think that it results in a more complete picture of the role of science in the modern world than does the more usual definition. Using these definitions of science and scientists, we find scientists scattered in all sorts of places in a modern nation. It is interesting to think of them all as the scientific community and to study the structure of this community and its relationship to the rest of society.

From the point of view of history and of social organization, the foundation of science lies in the universities. At one time they were the sole repositories of the knowledge that goes to make up science. In them is done a great deal of the research that is continually expanding the boundaries of scientific knowledge, and their professors pass on both the old and the new knowledge to the students who will use it during their working lives.

However, from the point of view of the individual boy or girl who seeks a career in science, the first—and often the most important—member of the scientific community is the public or high school teacher who first creates for them an interest in science. In addition, industry is beginning to challenge the universities both as a repository of scientific knowledge, and as the scene of new scientific discoveries; in fact, nowadays many well-trained scientists never do attend a university. Nonetheless it is still correct to say that the scientific community has its roots in the universities.

Scientists can be classified into three groups—teachers, applied scientists and pure research scientists. Strictly speaking, teachers should be regarded as applied scientists, but they are so important that they deserve a special classification. Without adequate teaching of science in the high schools, the scientific community could wither and die, and without a few inspired and inspiring teachers of science in the high schools, we would fail to attract to a scientific career a sufficient proportion of first-rate minds. Such a failure would threaten the continued development of our highly mechanized civilization.

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To follow the high school teachers, we must have in our universities, as professors of science, some of our very best scientists. One essential characteristic of science is that it is a living and growing entity. The student of science must early learn that his student days will never end. He must come to welcome the thought that he will never achieve complete mastery of his subject. In addition, some of the best scientists in each generation must be encouraged to devote their lives to the task of adding to man's store of fundamental scientific knowledge. The urge to explore new avenues of investigation, to perform new experiments and to peer more deeply into the workings of the physical world is infectious, and can be transmitted from generation to generation. Hence the need to have good research work going on in the universities. It is essential, not only as a training ground for a new generation of research workers, but also to give to all the scientists, including even the most practical engineers, some appreciation of the dynamic and ever-changing nature of their subject. In recent years there has been a tendency for pure research to migrate away from the universities to government and industrial laboratories where pay and working conditions are better. There is a real danger of this movement going too far. We must retain a proportion of our very best fundamental research workers in our universities.

Thus we see that, in the scientific community, the university professor plays a dual role. He is both a teacher and a fundamental research worker. Similarly, the research they do has a dual significance, because it not only forms an essential background for their teaching, as I have outlined already, but it also performs an essential part of the nation's contribution to the advancement of scientific knowledge. In early pioneer days Canada rightly imported most of its pure and applied research and most of its engineering, but Canada is now emerging as a full-fledged and independent industrial nation and is rapidly developing a self-sufficient scientific community of its own. This scientific community must be strong and well-balanced if it is to give adequate support to a rapidly growing economy and to the needs of defence. Such a community can only be healthy and effective if all parts of it grow in proper proportion; consequently, in our preoccupation with the teaching of science, and with the application of science in industry, we must not lose sight of the essential role of this fundamental research which is done partly in the universities and increasingly in government establishments and in industry. Spectacularly new fields of industrial activity such as electronics and nuclear power have come, not from the work of applied science, but entirely from the results of the most academic scientific research, done mainly in universities.

Some people argue that in a rapidly-developing and still young country such as Canada we cannot afford the luxury of fundamental research, and should direct all our energies toward applied research. I am sure that this reasoning is wrong. Experience all over the world has shown that only a very small proportion of the population has the genius to do important and creative fundamental research work. The people with these special qualities seem to occur with about the same frequency in different nations; therefore, it is reasonable to believe that we in Canada have our fair share of geniuses such as Einstein. If this is true, then it is part of Canada's responsibility to mankind to see that these geniuses have an opportunity to develop, and to make discoveries of importance. The cost of providing adequate facilities for fundamental research, to all those in any country who are really qualified to become independent fundamental research workers, is surprisingly small, and is one that will pay larger dividends than almost any other national expenditure.

I think our real problem in fundamental research is to see that we give adequate support to those who are qualified by heredity and training to do it, and avoid supporting in fundamental research a great many people whose abilities would be far better used in applied research or in engineering. This does not mean, of course, that only geniuses can do fundamental research; in any exploration there is a great deal of work to be done clearing trails and bridging rivers, and so it is in fundamental research. Many first-class research workers can be usefully occupied in following up and expanding the discoveries of the explorers, but there is always only a small number of real pioneers.

The line between fundamental research and applied research was never very sharp and is becoming less and less well defined. The motives of the research worker probably give the clearest distinction. The fundamental research worker is seeking new knowledge without thought of application. He is often followed by one (who is coming to be called a basic research worker) who is exploring defined areas to find applications for new knowledge, or alternatively to seek new knowledge within a defined field such as electronics. After him comes the applied research worker who seeks to apply new knowledge to the solution of specific industrial problems or to the design of a specific bit of equipment. Finally come the great body of applied scientists who use their scientific knowledge for purposes other than teaching and research. This includes, for example, medical doctors, chemists, physicists, mathematicians, geologists, biologists and—most of all—the engineers. These are the ones who apply the knowledge and experience of the whole scientific community to the solution of the practical every-day problems of building and managing our modern industrial society. In Canada they are needed not only to keep our industrial economy abreast of the changes that result from scientific discoveries, but also to cope with the expanding needs of a rapidly growing country. Because of the increasing demand for the services of engineers, Canada has become increasingly aware of the growing shortage of engineers. This shortage is as much due to a rapidly increasing demand as to a shortage of supply. The demand arises not only from our increasing population and the rapidly expanding exploitation of our natural resources, but also from the vastly increasing complexity of modern industry. A few years ago Canada had no highly complex industries such as the aircraft industry, electronics and nuclear engineering.

A striking example of both the change in the requirement for skilled engineering in a single industry and of the change in the nature of industry is shown in the following example from the aircraft industry.

The American P-51 fighter was brought to its first flight in 1940 with approximately 42,000 man-hours of engineering. The XP-86, the forerunner of the Sabre, flew in 1947 after 620,000 man-hours of engineering. The YF-100, which can be regarded as a supersonic successor to the Sabre, first flew in 1953 after 1,440,000 man-hours of engineering. This is a staggering increase in the engineering effort required to produce a series of aircraft, all of which have a similar purpose and each of which was of similar standard of performance in relation to its contemporaries. The same process is occurring throughout industry and will continue and accelerate. Thus, atomic power plants will require design teams many times the size of those used for steam or hydro plants. New electronic devices will be vastly more complex than the ones that they replace, and so on. Another factor that contributes to the shortage of engineers is that scientists and engineers are continually invading new fields. Engineers in particular are now frequently appearing in top management jobs. It is idle to suggest that these people should be kept at

strictly engineering work. They are superior executives in technical industries because of their engineering training and we cannot afford anything but the best in top management. Consequently, as Canada grows the supply of engineers must grow or the pattern of our social evolution will be seriously altered.

I have described the scientific community in a general way as consisting of high school and university teachers, pure and applied research workers and applied scientists and engineers of a variety of kinds. Another way of looking at the scientific community which helps in understanding its structure is to consider how the community is built up within an individual industry. A typical and very important example is the aircraft industry. At the basis of the scientific success of the Canadian aircraft industry lie the public and high school teachers who first attracted competent people into a career in science and gave them their early education. Following them are the university teachers and research workers who have given the students advanced knowledge and, above all, have inspired them to continue learning and exploring throughout their lives. These university research workers also form the basis of the scientific research organization that underlies the aircraft industry. They work on general principles without thought of immediate application. Next come the basic research workers who, in Canada, are mainly in the National Research Council and the Defence Research Board; they attempt to apply new scientific knowledge to the solution of general rather than specific aeronautical engineering problems. Finally, in the aircraft companies themselves are the applied research workers and the design and production engineers who seek to combine all this knowledge with industrial know-how to meet the practical needs of the R.C.A.F. and of the commercial air-lines.

I have thus far given special emphasis to the branches of the scientific community that spread into the manufacturing industry. It is obvious that there are equally important branches spreading into almost every part of our national life. Scientists and engineers play an essential role in agriculture, mining, forestry and fisheries, transportation and other public utilities. The whole development of our natural resources and primary industries depends upon their work. On reflection, it is evident that the work of the scientist pervades every aspect of our economic life, and has a profound effect on the health and material well-being of every Canadian.

I have only mentioned incidentally the tremendous contribution that the scientific community makes to national defence. Members of the community will be found playing essential roles, not only in research for defence and in the defence industry that produces our weapons, but also in the armed forces themselves. With the increasing complexity of weapons and the accelerated pace of development of new weapons systems, it will require our very best efforts in all these fields just to keep abreast of the armament of potential aggressors.

I hope that this brief outline of the structure of the scientific community in Canada, will have added something to your understanding of the place of science in a modern community. However, in conclusion I feel it wise to add a word of warning. In our enthusiasm to increase the number of scientists and engineers that are trained in our universities, we must not weaken or destroy any of the other similar professional communities that are so essential to the welfare of the nation. We must try to foster a balanced and healthy growth, not only within the scientific community but throughout the nation as a whole.

(iv) Our Position in the World

By Dr. F. T. Rosser,
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The subject assigned to me in this series of broadcasts is a discussion of the position of Canada relative to that of other countries in the world as regards the supply and development of professional manpower.

Let us first be clear about what we mean by professional manpower. Most of us are average individuals, with no two exactly equal in our abilities. There are a few who, unfortunately, are handicapped in various ways and much is done in Canada to help these cope with the problems of living. Then, there is a small group of intellectually gifted people, among whom the very best may possess real genius. It is from these clever people of above-average intelligence that our scientists, engineers, doctors, lawyers, economists, clergymen, business leaders, teachers and other professionals must be drawn. Mental superiority has no boundaries and is not limited to wealth or privilege. It is well known that gifted children may be born into any home from the lowliest to the most lavish. Our professional manpower, therefore, is drawn from all kinds of homes and is made up of those gifted people who have received a specialized training in either the arts or the sciences and are actively practising the profession for which they are qualified.

Now we can move on to consider first, the supply and second the development of professional manpower in Canada as related to other countries. Our fabulous natural resources, together with enough professional manpower capable of providing outstanding leadership in a very complex world, could put Canada in the forefront of the nations. Canadian environment, I am sure you will agree, is at least equal to that found anywhere else in the world and the proportion of gifted people in Canada is certainly not lower than in any other country. The really significant question to discuss is, therefore, the second one: How does the *development* of our intellectual resources compare with that of other countries and what can we do to improve the handling of our professional manpower?

In the field of education Canada has, for nearly a century, been among the world leaders by providing free education for all children up to the university level. For the most part our schools have been geared to meet the needs of the average child, and it is only recently that serious attention has been given to the importance of providing special educational facilities for the gifted children. We do need to give greater attention to early recognition of superior children and to the improvement of educational programs for them in both public and high schools. It is, however, at the highest educational level that a crisis is approaching rapidly. Without immediate expansion of facilities, there is very grave danger that in the near future our universities may not be able to handle all the students qualified for a university education and desirous of training for a professional career. If such a situation were allowed to develop we would certainly be in an unfavorable position as compared to

other countries. There is every indication, however, that the public has been awakened to the need, and that steps are being taken to prevent Canada from falling behind in the development of one of our greatest natural resources, that of our gifted people.

I would like to consider now, more specifically, scientists and engineers as a special part of the professional manpower problem. We are, of course, short of scientists and engineers because of the enormous industrial development that has taken place in Canada since the end of World War II and for which large numbers of scientists and engineers are required. Whenever full use is made of the resources of gifted people the number in one group can be increased only at the expense of other groups. A changing society demands such constant and continual adjustments. For example, in 1911 Canada had about as many scientists and engineers as lawyers—approximately $6\frac{1}{2}$ per cent of professional workers being in each category. Forty years later, in 1951, $18\frac{1}{2}$ per cent of the professional people in Canada were scientists and engineers and a little more than $2\frac{1}{2}$ per cent were lawyers. If the percentage of scientists and engineers in our society must be increased still further it can be accomplished only by a relative decrease in the numbers in other professions. Some countries have made engineering so attractive that religious leadership, for example, has almost been eliminated, a result that Canadians would not fancy.

In connection with our scientific manpower shortage, alarming comparisons are sometimes made between the number of engineers being produced in Canada and in other countries. Such comparisons can be very misleading. Before a valid comparison can be made we must be sure that people with similar professional training are being compared. In Canada the term "engineer" is applied almost exclusively to those who have obtained an engineering degree from a university. This is not so in Europe where, in most countries, there is a very comprehensive system for training both craftsmen and engineers. Boys wishing to become ordinary engineers leave school at 15 or 16 and become apprentices in industry. A few years of practical training is followed by about three years of study in a technical school. When such a course is completed a man may be given an engineering diploma and have the right to call himself an engineer. There is nothing comparable to this in the Canadian educational system, but many of our skilled technicians who have taken night school courses, or have improved themselves by other means, would be comparable in training and skill to these continental engineers. Canada graduates 1,350 engineers per annum. Some other country of comparable size may produce 3,000 engineers per annum, but it is meaningless to compare them unless the educational standards of the two countries are evaluated, the immediate needs for engineers contrasted, the background of the profession assessed and other relevant factors appraised.

We are not alone. The shortage of engineers and scientists is a world-wide problem that most countries are studying seriously. In order to improve our situation in Canada and to maintain a favourable position in relation to others there are a number of things to which we could give attention and I shall mention some of the more important.

The most serious problem concerning the future of science and engineering in Canada is the shortage, in both the secondary schools and the universities, of well-qualified teachers. Improved salaries and social status are fundamental to the successful solution of this problem at all levels and should receive most serious attention. In Russia, for example, a university chair is regarded as the most important post in the professional field and

accordingly, professors receive the highest salaries (higher even than those of industrial engineers). Industry in particular should insist that a reasonable number of graduates be diverted to the teaching profession; otherwise the supply of professional engineers and scientists could be dried up at the source. To rob the schools and universities of their outstanding men is to kill the goose that laid the golden egg.

The continuous increase in the amount of knowledge uncovered by research makes it difficult for teachers to keep up to date. In Canada more could be done to acquaint science teachers with the latest scientific and industrial developments by expanding the number of vacation courses. Again, industry could help by providing financial assistance to both universities and teachers, thus encouraging universities to establish summer institutes and the teachers to attend them.

The co-operation between universities, industry and research institutes in Canada is well ahead of that in many other countries but still more could be done to make full use of the abilities of outstanding research people. Industries could sponsor more fundamental research work at the universities so long as such sponsorship did not interfere with the professional freedom of the university professor or the research worker. They could also help by providing funds to endow special chairs or to purchase expensive apparatus, and by making available for teaching purposes plant facilities not in constant use. Both government and industrial laboratories might help by loaning outstanding men in specialized fields to lecture or direct research projects for the universities.

It seems to me that it would also be most desirable from the Canadian point of view to follow the example of many other countries in a much greater extension of the worker's opportunities for improving his education while working on the job. Workers at all levels in industry should be encouraged when they are young to improve their training and so to fit themselves for work at higher levels. This should be done particularly in the engineering field.

In many other countries much greater use is made of women in all fields of science, medicine and engineering. In fact the female proportion is about 50 per cent over all the branches of engineering in Russia compared with less than 1 per cent in the United Kingdom or Canada. In thinking that engineering is socially less creditable and less suited to women than other careers perhaps we are neglecting a potential supply of good engineers that would help to solve the shortage problem. It is generally recognized that women do have a special aptitude for medical, biological, biochemical, analytical and statistical work. We have a reserve of trained women above the age of 40 whose children have grown up and whose housekeeping duties are light and it is possible that much greater use could be made of them in laboratories and in teaching.

The practice of stockpiling research workers is one which is affecting the supply of scientists and engineers to some extent. Companies sometimes hire more professional people than they need, or assign them to jobs which could be done by people with lesser training or could be done just as well by people with an entirely different training. In other words, engineers may be used as technicians, salesmen, administrators, etc., in jobs that should be done by other people. Professional training can also be wasted by inadequate provision of laboratory and clerical assistance. Expert research workers particularly should be relieved of as much routine work as possible so that they may devote their time to the research for which they have been trained.

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It has been amply demonstrated that professional workers very often remain mentally vigorous and active long after what is regarded as the normal retiring age. In fact there is no fixed retiring age for those in such independent fields as medicine, the church, and politics, where many carry heavy loads of responsibility long after they have passed three score years and ten. The same thing would be true of scientists and engineers if they were not required to retire at 65. Older professional workers can be invaluable in many scientific service capacities. A number of universities in other countries have already raised the retiring age for their staff above the 65 years commonly adhered to in Canada.

The interchange of students and research workers between one country and another is a very good practice, particularly when it allows the student to receive specialized training. At the same time it must be recognized that a number of students who seek training and experience in another country will not return home. We are all aware of this since so many young Canadian students have remained in the United States. Nevertheless, not since the depression years in the thirties has Canada been a net loser. Since we could ill afford to be in that position again the reasons for our loss of these expensively trained and valuable citizens should be studied carefully and every possible action taken to prevent it. There is always the possibility that our supply of professional immigrants might dry up quickly leaving us in a very unfavourable position.

The crisis brought about by the shortage of scientists and engineers in Canada is very similar to that of other countries. In order to maintain ourselves on a par with others we must recognize our weaknesses and take quick action to overcome them. As I see it, of all the ways I have mentioned for improving the situation—emphasizing the importance of higher education, making full use of the abilities of research people, extending on-the-job training, employing more women, avoiding misuse of trained men, using the over-age but active workers, and preventing the loss of professional people to other countries—by far the most important is immediate action to give our teachers a higher standing in the community in keeping with their real worth, since, in this respect, we are already far behind as compared with many other countries.

SECTION 2—EDUCATIONAL ASPECTS

(v) High Schools' Needs

By Dr. Garnet T. Page,
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The year 1956 will be remembered for a variety of reasons. Our own principal memory will be the large number of meetings held by industrial groups, educators, community groups, and other organizations to discuss the many factors contributing to the present need for more scientists, engineers and university graduates in other fields. There have been four main threads of agreement running through all of these discussions. Each of them constitutes a real challenge.

The first point of agreement is that our Canadian universities and colleges are, in general, able to handle their share of the responsibility for the education and training of the university graduates we require in every field. Their major need is an adequate supply of money to allow them to recruit and pay their instructional staffs, and to enlarge their facilities as necessary.

The second point of agreement is that, as long as we have an expanding technological economy, we will continue to require more scientists and engineers. The state of requiring such personnel is an indication of national health, and even though we may call it a "shortage", it should not be construed as a cause for panic. Rather, those who require these trained men should face up to this new and apparently permanent condition, and assume the new responsibilities which go along with it. The two new responsibilities which are pre-eminent are a greatly increased amount of financial support for our universities, and a recognition that the career of a scientist or engineer must provide adequate incentives and rewards, both professionally and financially.

The third point of agreement is that the present apparent shortage of certain types of trained personnel could be alleviated in some measure by a more efficient utilization of professional manpower by business and industry, and by the employment of technicians to relieve them of many non-professional "chores".

The fourth point of agreement is that the foundation of Canadian education, the elementary and secondary school system, needs a thorough examination and strengthening. We are in great need of more teachers and, in many instances, teachers who possess qualifications in the subjects they teach, in addition to the skills of modern pedagogy. In particular, we need a system of primary and secondary school education that will identify and inspire our future specialists in all the fields of higher learning, that will instil the discipline of study and thought in our young people, and that will do more for them than provide the mechanics whereby they may pass a set of departmental examinations.

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The responsibility for correcting this last problem rests with the people of Canada, and it is incumbent upon all groups of citizens to lend their full support to its solution. As the employers of teachers, the Canadian public must remember that, in order to attract sufficient numbers of the best people to this profession, the career of teacher must also provide adequate professional and financial incentives and rewards.

The Basic Problems

The principal reason for our changing manpower needs appears to be the increasing application of the techniques of automation to our economy. Automation brings with it a greatly increased responsibility for management to plan manpower requirements with regard to both technical personnel and labour. Adequate planning will, in large measure, avoid the serious social and economic dislocations which have occurred as a result of some earlier industrial revolutions. Plans for the numbers, skills, and professional qualifications of future manpower requirements should be made far in advance, and particular attention should be paid to the possibility of training potential technicians and management personnel from among those now employed.

In the future many more Canadian employers will adopt the techniques of automatic production in one form or another. It appears that companies ranging from small to very large will take advantage of the technical possibilities of automation in both the office and the plant. How far and how fast this development will take place does not appear to depend so much on available capital and related factors as the availability of well-trained management personnel, scientists, engineers, and technicians.

Far-reaching changes are taking place in the machines and processes of industry, agriculture and business as a result of harnessing new sources of power and the development and application of automation.

These changes increase the pace of technological development, bring enormous benefits to society, and at the same time provoke profound alterations in the work and occupational pattern of the population.

We cannot yet see the exact nature of these changes, but the phases of the industrial and scientific revolutions through which we are now passing require a marked up-grading and a higher degree of flexibility of the labour force. It lays special stress on the full development of high level talents, and will produce basic and widespread changes in our social and cultural life, with which our educational system must deal. The whole picture is further complicated by the increasingly rapid rate of all of these changes.

Many predictions and projections have been made in recent months, showing the vast number of people trained in all manner of skills which Canada's educational system must produce within the next 25 or 50 years. These shrewd guesses are almost terrifying. Even when we look at the present situation, and our accurate knowledge of requirements for the next two or three years, we find cause for great concern.

For the next few years, the net Canadian requirement for new engineers is expected to increase at an average rate of 11.4 per cent, and for scientists at an average rate of 9.8 per cent. The greatest increase in requirements are expected to occur in the industrial area, with an anticipated 12.2 per cent annual net increase for both engineers and scientists.

Even now, almost all of our schools and universities are having great difficulty in recruiting new professional teachers and about 75 per cent of industry is experiencing this same problem. The serious and damaging effects of these shortages are:

(*a*) a serious curtailment of production and expansion plans;
(*b*) curtailment of development and research activity;
(*c*) overloading of present personnel;
(*d*) necessity of filling positions with inadequately trained personnel, and,
(*e*) potential shortage of future executives.

Added to this we are confronted with equal or greater shortages of personnel trained in the non-technical fields, with an attendant serious effect on our economy and on our way of life.

We look to our educational systems for solutions to most of these manpower problems because, in the present manpower situation, Canada has a particular need for trained abilities at a high level. This need has a new urgency, partly because of the current demands of industry and business and partly because many schools have tended to neglect the full education of their pupils.

Canadian schools are clearly obligated, in the light of our manpower needs, to intensify their search for means whereby waste of talent can be reduced. It must never be forgotten that the best development of the talents of every boy and girl is the prime concern of our educational system.

We have been impressed with the obvious fact that, over the next five years, very little can be done about our supply of personnel except to make the best of what we have, giving all possible help to our universities, promoting the re-training of some segments of the existing labour force, improving our recruitment methods both in Canada and abroad, and related activities.

However, when we look ahead into the next 10 to 50 years, we are faced with the necessity of taking some action about what appears to be a fundamental problem, that of strengthening our primary and secondary school systems. We are in dire need of more teachers and, in many instances, different teachers. We need a system of primary and secondary school education that will serve to inspire and identify our future specialists in all fields of higher learning, and that will instil the discipline of study and thought in our young people.

After reviewing this problem in some detail, it has become obvious that the great impact of modern technological progress demands that immediate action be taken at the pre-university level to ensure the best possible teaching of science and mathematics. It has become equally obvious that the high school teachers of science and mathematics are the key to many of our long-range problems of professional manpower.

Recent studies indicate that Canada's requirements for professional personnel will double over the next 20 years, with scientists and engineers being required in the largest numbers, closely followed by specialists in the health professions, the social sciences, the legal profession and the humanities.

These studies also indicate that Canada's university-age population will probably double during the next 20 years, thus approximately matching the expected doubling of the demand for professionally trained personnel over the same period. However, there are certain limiting factors which must be considered before assuming that our requirements for professional personnel will be supplied automatically.

The first factor is a recent general anti-intellectual trend amongst our high school population—a tendency to shy away from proceeding to a university or technical school education in pure or applied science.

One of the main reasons for this is the lack of a sufficient number of properly qualified high school teachers of science and mathematics, and a lack of methods for up-grading the quality of teaching by those who may find it necessary to teach these subjects. This condition leads to an almost complete absence of one of the most important functions of the high school teacher of science and mathematics—that of identifying and inspiring our future scientists and engineers.

The second factor is that we have received a very low proportional net increase in population from immigration in the very professional classes in which our shortages are most acute. Our future in this field is very uncertain, and depends upon many considerations, both in Canada and in the countries from which most immigrants to Canada come.

The third factor is that our university and technical school facilities have very definite limitations today, and cannot accommodate any sizeable increase in student enrollment and maintain educational standards without a considerable expansion of teaching staff, accommodation and equipment.

The fourth factor is that, in general, Canada is not yet making the most efficient use of its present supply of professional personnel. The proper use of a professional scientist or engineer requires that supporting technicians be employed to relieve him of a number of tasks which are essential to his work, but which are not necessarily best performed by him. Canadian employers have not yet solved all aspects of the technician problem in its relation to the shortage of scientists and engineers, and training facilities for technicians are still woefully scarce in many areas.

Undoubtedly the most important single answer to the problem is money, both for higher salaries and for added facilities. However, while it is probably true that higher salaries may attract a larger number of engineers and scientists to high school teaching as a career, there are many other factors to be considered in solving the problem facing us at the present time. Attention must be given to such factors as:

better preparation of teachers;
reduced load for teachers;
improved prestige for teachers;
financial assistance for teacher training;
improved curricula and courses;
better facilities for teaching;
methods of up-grading the efforts of existing teachers, and,
effective utilization of qualified teachers.

Immediate action that is being taken or being planned includes promoting the more efficient utilization of our present supply of trained personnel, principally by the employment of technicians; the up-grading of the teaching of science and mathematics in our secondary schools and increased financial support by industry of the existing educational facilities and of promising students. In addition, the Federal Department of Labour has conducted surveys of the supply and demand for technically trained personnel in 1954 and again in 1956, the Dominion Bureau of Statistics is collecting data on

both the facilities and product of our educational system, and other related information is being assembled by the National Research Council of Canada and by professional societies.

Conclusion

We consider that this subject merits the most careful and serious consideration by the appropriate authorities in this country. We realize that formal education is a prerogative of the provincial governments, and we urge that the universities, professional societies, industry, the teachers themselves and the general public co-operate with the provincial and local authorities in developing plans of action which will tend to assist our primary and secondary schools to make an adequate contribution towards:

1. Supplying Canada with the well-trained engineers and scientists that are required.
2. Offer the type of instruction that will inspire those with the required aptitudes to go on to university training in all fields, *or* to proceed for training in what is hoped will be a very much larger system of technician-training institutes across the country.
3. Provide *all* secondary school students with an opportunity for a more intelligent understanding of the world in which they live.
4. Provide *all* secondary school students with the fundamental knowledge required to earn their living in a technological age.

(vi) Vocational Guidance in High Schools

By Professor M. D. Parmenter
Director, Guidance Centre, Ontario College of Education, University of Toronto

Earlier talks in this series have pointed to current and future problems in the matter of shortage of professional and technical manpower in Canada. A serious shortage exists and it is evident that our whole economy is suffering because of this shortage. It also seems likely that the situation may become much worse before it becomes better unless we bend every effort towards seeking solutions to manpower problems.

Actually, there would seem to be three main sources of supply as far as professional and technical personnel is concerned. One is through immigration, whereby to some extent we rob other countries of professional and technical manpower perhaps badly needed at home, and whereby certain other countries steal from us in the same way. Our net gain through this whole process is sometimes not very impressive. Another source may more and more be through changeover of able people from occupations which no longer require as many workers as before because of developments under the general heading of automation. Electronic devices, computers, the forthcoming phonetic typewriter and other machines will undoubtedly make it necessary for many workers to abandon their present occupations and to re-train for work in other occupations—perhaps occupations in the professional and technical group. Such re-training, however, may be costly and time-consuming. The third source is the young people now in elementary and secondary schools and universities, obtaining an education and preparing to take their places in the world of work. This third source is undoubtedly the most important and most promising of all for the future. These young people constantly coming on through our educational system, selecting occupational goals and training courses, dropping out or graduating from school, constitute our labour force of the future. These young people are Canada's most important asset and everything possible should be done to so arrange matters, that each and every one of them will have the maximum opportunity to develop his talents to the full, and will have the maximum opportunity to employ his talents to the full somewhere in the Canadian world of work. This whole business of making the most of potential is of the utmost importance, particularly in times of shortage. Gone are the days when we cut down our forest trees without regard for waste and future requirements. Conservation, avoidance of waste, efficient use of resources are paramount in our thinking and planning in connection with forests, lands and other natural resources today. Gone, too, should be complacency about the boy with the necessary talents to become with training, a scientist, a physician, a teacher, who drops out of school and enters some occupation where his special gifts will not find expression.

In the "Republic, Book 2", written centuries ago by Plato the Greek philosopher, there appears the following statement:

> "In the first place, no two persons are born exactly alike, each differs from each in natural endowments, one being suited for one occupation and another for another".

Vocational guidance, however, whenever, and wherever practised is based essentially on this important truth expressed by Plato. Vocational guidance is concerned with achieving a reasonable fit between individuals and occupations and so with cutting down on the tremendous waste which ensues when individuals select unsuitable career goals, pass up opportunities for the type of training they should obtain, in terms of their academic intelligence, special aptitudes and basic interests, and land in occupations for which they are ill-suited.

This problem of selecting a suitable occupation, planning toward it, preparing for it, entering upon it, and making progress in it, is something with which young people usually need considerable assistance. To render some of the assistance needed, programs of guidance services have been set up in most secondary schools, and to some extent in elementary schools and other educational institutions. Through such programs we try to do many important things. First of all, we try to help the student, his parents and his teachers to a better understanding of the student's strengths and weaknesses. Such an understanding is essential as a first step in career planning. To aid in this connection, schools now obtain over the years detailed information concerning each student—information about his hobbies, vocational ambitions, spare-time jobs held, study habits, academic intelligence level, special aptitudes, temperament, direction and strength of his interests, and so on. Student information forms, psychological tests, interest inventories and many other special tools are used to bring in such helpful data. Information obtained through the use of these tools is recorded in systematic fashion on the student's cumulative record card or folder. On these same cards or folders, grades obtained on school subject examinations are accumulated and a record is kept of significant behavior observed, or pertinent data assembled, through individual interviews with students and parents. Thinking in terms of professional and technical manpower, this procedure, commencing as it does in the elementary school, helps in spotting those students who seem to possess potentialities which, if properly developed, should lead to success in the professional and technical area. Through individual interviews and special group work in subjects such as Occupations and in other ways, students are encouraged and aided in taking stock of themselves and in discovering the nature of their personal strengths and weaknesses. This same business of studying students as individuals brings to light, of course, needs not being taken care of in adequate fashion through existing educational programs. Knowledge of such needs sometimes leads to desirable changes in training programs. Secondly, through its program of guidance services, the school tries in every possible way to provide information about the world of work and about requirements for entering and succeeding in various job fields. The following are a few of the many devices used in this connection:

> *Classes in occupations or careers,* through which an attempt is made to discuss some of the important problems related to career planning, and through which students obtain an overview of the Canadian occupational world.

Planned use of occupational information files, containing printed materials on various individual occupations. The Department of Labour at Ottawa has published a number of excellent monographs dealing with individual occupations as they exist in this country. A list of titles available at nominal cost may be obtained by writing to the Economics and Research Branch, Department of Labour, Ottawa, Canada. Then, too, The Guidance Centre, Ontario College of Education, has published to date 117 separate monographs on occupations in Canada, each dealing with nature of the work, working conditions, preparation needed, remuneration and so on in a particular occupation. Additional titles are being added to The Guidance Centre's series constantly. These monographs are available to schools, parents, students, anyone, at a nominal price. For a list of titles write to The Guidance Centre, Ontario College of Education, Toronto, Ontario. Another device used in providing occupational information is *Films and Filmstrips on occupations in Canada.* More and more of these are appearing. Some of them are produced for, and circulated to schools, by professional associations interested in providing youth with information about the professions the associations represent. Other occupational films and filmstrips are produced by, and available from the National Film Board and industrial organizations.

Still another procedure employed to provide occupational information is what is known as a *Careers Day.* On the occasion of a Careers Day speakers representing various occupations come to the school and talk to groups of students desiring information about physician, engineer, accountant, teacher, machinist, or other occupations in which the visitors are engaged.

Industrial visits and many other devices and techniques are used to assist in providing accurate information about the world of work—information needed by all students concerned with career planning.

As mentioned, guidance workers try through their programs to help students to know themselves and to know the Canadian occupational world. Guidance workers help in other important ways, too. One has to do with providing information about opportunities for training in secondary schools, universities and other institutions. Particulars about various subjects and courses, their values, the occupational direction in which they lead, entrance requirements, fees, scholarships, bursaries and loan funds—information needed by students and their parents trying to develop suitable educational and occupational plans, is provided by guidance workers.

With some understanding of himself, of occupations and their requirements, and of opportunities for training, a student is in a better position to do, with his parents, a better job of career planning than would otherwise have been the case. With such understandings, there is less likelihood of the boy who, by virtue of his special pattern of talents, could probably become a competent geologist, becoming instead, a street car conductor. In short, vocational guidance programs make more likely the efficient use of manpower potential.

A number of rather important points should be kept in mind in connection with this whole process of educational and vocational planning.

First of all, in our democracy, the individual has the right, with certain qualifications, to make his own decision about a future career. Competent guidance workers provide information helpful in career planning, and try to

make available, too, opportunities for the maximum development of the individual. But the guidance worker does not dictate and does not take over from the student and his parents, the responsibility for making career plans.

Secondly, guidance workers and teachers cannot, of course, do the *complete* job of helping each student to a better understanding of his strengths and weaknesses, of spotting those with special talents, and of helping students to a better understanding of the occupational world. Those outside the school must assist in their capacities as parents and members of the community. The wise parent watches his child for indications of special talents. For example, investigations show that the budding scientist or engineer often exhibits early in life special ability and interest in mathematics and science as school subjects, and special interest in hobbies with a scientific slant—such as photography, collections and chemistry. Such a child reads a lot and has a large vocabulary. He is curious about how things work and is often clever with his hands. Parents can help, too, by supplying their children with books, playthings and other materials which are definitely related to jobs and by providing opportunities for young people to observe and to talk to workers in various occupations.

There is a third important point to remember in connection with vocational guidance, and it is this: as has been indicated, career planning includes of course educational planning. Sound, adequate training, is necessary for most occupations and certainly for those in the professional and technical area. This matter of adequate training, particularly for the gifted student, is causing much concern these days. One thing is certain, however, namely, that an educational program, no matter how set up on paper can be only as good as the teachers who take part in it. This means that we must do everything possible to increase our supply of able teachers in mathematics, science, languages and other subjects. And we must try to retain as teachers those able individuals who have been quite understandably leaving teaching during recent years, to accept more lucrative positions in industry.

Finally, we should keep in mind that many, many students are gifted in one way or another. Present emphasis on the need for engineers and scientists, and on the importance of mathematics and science in our modern world, should not blind us to the genuine need which also exists for those educated chiefly through the humanities.

(vii) Technological Institute System

By H. H. Kerr

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In an address a year ago on the subject of education, Sir Anthony Eden said: "The prizes will not go to the countries with the largest population. Those with the best systems of education will win. Science and technical skill give a dozen men the power to do as much as thousands did 50 years ago. Our scientists are doing brilliant work. But if we are to make full use of what we are learning, we shall need many more scientists, engineers and technicians."

The shortage of scientists, engineers and technicians is just as great in Canada as in other countries; and here as elsewhere industry and all levels of government are endeavouring to find an acceptable solution. There are many causes for this dearth of engineering manpower but one important factor is that the ratio between engineers and other types of employees is rising. Fifty years ago, this ratio in the manufacturing industries was 1 to 300. Because of the tremendous changes that have taken place in production methods, the ratio is now 1 to 50. Here is a prime reason for the shortage of engineers, and the requirements for engineering personnel at all levels is such that the ratio may go even higher.

The demand for goods, services, and electrical energy is constantly increasing. The consumption of steel is often used as a measuring rod of economic progress and the steel mills on this continent are producing ten times the tonnage they did 50 years ago. Electrical communication, in all its various forms, has made tremendous strides. There can be no comparison between the crystal receiving set of the early 1920's and the modern television receiver with its multiplicity of tubes and circuits. The same applies to transportation. There is a great deal more engineering value in today's automobile than there was in the famous "tin lizzie" Fords of a generation ago and the 1956 skyliner is a much safer, though a faster and a more complex machine, than the "flying crates" which flew over enemy territory during the first World War.

We are busy building automatic and automated machinery which, while producing goods better and more cheaply, does release manpower. Unfortunately for the present shortage, the manpower is being released at the lower end of the scale of skills rather than at the engineering level. Conversely, the complexity of our present day machines, and manufacturing processes they entail, demand more and better trained engineers and technicians than they did in the past.

Another factor is that because of the high academic ability required, the ratio of professional engineers to the total population cannot be greatly increased unless graduation standards are to be lowered. Such a step is not desirable from an industrial, educational, or engineering point of view. Other solutions to the shortage must be sought and one of the most promising is the training of more highly qualified technicians and technologists. The

engineer should be employed in creative work, such as, design and development, and in management positions, but it is generally recognized that a great many are being used on less creative and less important tasks. The well-trained engineering assistant or engineering technologist can and should relieve him of most of the routine work and free him to perform those duties for which he is especially educated.

This raises the question, "What is a technologist and what is a technician?" A generation ago, it would not have been difficult to define his duties and responsibilities, for at that time he was recognized as a person who was fully conversant with the technicalities, both theoretical and practical, of a particular subject. In the intervening years, the boundaries of the term seem to have broadened, until they now include a surprising number of persons. Under the circumstances, it is understandable why a number of firms have found refuge in establishing six to eight categories for those who desire to be known as "technicians".

In this maze of confusion, one helpful definition has emerged. It concerns a comparatively new term, "engineering technician", a term which because of its newness may be unfamiliar to a great many people. It was adopted by the European and United States Engineers' Conference at a meeting in Geneva about two years ago, and was approved subsequently by the Conference of Commonwealth Engineering Institutions. The Engineering Institute of Canada is the Canadian member of the Commonwealth Conference. The definition in part is as follows:

> "An engineering technician is one who can apply in a responsible manner proven techniques which are commonly understood by those who are expert in a branch of engineering, or in those techniques especially prescribed by professional engineers. The techniques employed demand acquired experience and knowledge of a particular branch of engineering combined with the ability to work out details of a task in the light of well-established practice."

In order to make it acceptable to several countries with varying points of view, the definition had to be framed in rather vague terms. It is important, however, that the name "engineering technician" was officially adopted by the professional engineering organizations.

A few months ago, the Association of Professional Engineers of the Province of Ontario appointed a committee to study the situation and as a result of the deliberations of that committee, the Association has instituted a voluntary scheme for the classification and grading of this type of engineering personnel. Five grades were established—Engineering Technician, Grade I, Grade II, Grade III, Grade IV, and Grade V.

The highest category—Engineering Technician, Grade V—consists of persons who have passed the intermediate examination, or equivalent, of the Ontario Association of Professional Engineers. Because of the recognized standards of attainment they must meet, and because of the responsibilities they are thus able to assume, individuals in this grade and in the grade immediately below (Engineering Technician, Grade IV), are frequently categorized as "engineering technologists". The qualifications for the remaining grades are progressively lower, both as to academic qualifications and practical experience, but provision is made for the ambitious technician to progress from one grade to another, provided he is willing and able to qualify himself. For a small fee, the Association is prepared to issue certificates to members of each grade. This scheme is considered to be a forward advance

in the training and standardization of non-professional engineering personnel and the move has been enthusiastically received by both the engineering profession and industry at large.

Only during the past few years have the capabilities of the engineering technologist become recognized. For the past 50 years, the engineering faculties attached to many of our universities have offered excellent courses on both the undergraduate and the graduate levels. We have also had various good schemes for the training of our skilled craftsmen, but the education of the engineering technologist has been neglected, probably because it was only recently that Canada evolved an industrial economy. Since its establishment in 1948, however, the Ryerson Institute of Technology with its impressive growth has helped to direct attention to his training and his potential value to a company. Since that date, moreover, there has developed a great shortage of professional engineers, and employers generally have turned to this new source for assistance to fill their engineering needs.

The remainder of this address, therefore, will be devoted to the recruitment and the training of this type of employee who occupies an important position in industry and who makes up a group in which the engineers themselves have a special interest.

The three-year technological institute where the engineering technologist receives his training offers a type of curricula designed to produce persons who will make good engineering assistants, or who will occupy other positions on the same level in the production, installation, or maintenance fields. Candidates for admission should be practically-minded individuals, but, since they will not be called upon to produce the intricate designs or to make decisions involving highly technical data, it is not necessary for them to take the advanced theoretical subjects, a knowledge of which is required of the engineer. This should not imply, however, that he need not be a person possessed of an intelligence considerably above the average. As a matter of fact, he must have a learning capacity equal to the average applicant for a college course. His ability has to be necessarily high since an engineering technologist must possess a keen mind if he is to act successfully as an aide to a fully qualified engineer.

The first source of recruitment, therefore, is from the pool of able secondary school graduates for whom this type of curriculum has a basic appeal, or who for one reason or another do not wish to undertake a full engineering course. A second source is from industry itself. There are always a number of persons who, through circumstances beyond their control, are forced to leave school at the end of Grades XII or XIII and seek employment. A few years later they may find themselves financially able to resume their education.

It should not be assumed, however, that engineering technologists should be graduated by tens of thousands. Actually, a reasonable ratio in the United States is estimated to be one and a half such persons for each engineer. In Canada, many of our factories are branches of industries whose home plants are across the border. Consequently, a good deal of engineering work which ordinarily would be done here is performed at the head office. There is a possibility, therefore, that the ratio in Canada could be increased to two to one.

The Canadian universities graduated in 1956 about 1,800 engineers, which means that between 2,700 and 3,600 additional engineering technologists should have been prepared this year to take their places in Canadian

industry. Actually, the number was less than 400, which surely emphasizes what was previously intimated, that in this country we have a very unbalanced ratio of engineers and engineering technologists.

Perhaps I can best describe the training of a technologist by referring to the curricula offered by the Ryerson Institute of Technology, which is one of the very few institutions in this country that is staffed and equipped to provide suitable training for this type of specialist.

Ryerson is a provincially owned and operated institution and, while the instruction is on the junior college level, the courses are terminal in character. This means that they are not specifically designed to provide the necessary requirements for entrance to a university course, although each year a number of our graduates do seek admission to engineering colleges.

The Ryerson engineering technology courses—electronic, electrical, chemical, mechanical, metallurgical, instrument, architectural, and aeronautical technology—are of three years' duration, and the minimum entrance requirement is the Ontario Secondary School Graduation Diploma obtained at the end of Grade XII. The first six of these courses have been accredited for technical institute purposes by the Engineering Institute of Canada.

While emphasis is placed on the technical subjects, the curricula are kept as broad as possible in order to ensure that the students will have some concept and understanding of the world around them, and of the opinions and thoughts of the great men of the world, both past and present. Students, therefore, receive instruction in English for three hours per week during each of the three years of their courses. They also take such subjects as economics, related science and mathematics, industrial organization and management. Neatness and tidiness in dress and manner are stressed, for such things are important.

The members of the teaching staff have endeavoured to establish and maintain good educational standards. They have insisted that the graduates be young men and women of competence and integrity. That these standards are very acceptable to industry may be judged from the fact that the demand for the graduates far exceeds the supply. In a number of courses the ratio is four to one.

Although almost two-thirds of the total enrolment is in the engineering technology curricula, Ryerson offers courses on the same level in such non-engineering fields as the graphic arts, business, hotel administration, radio and television arts. The number of courses listed in the day school calendar is 22 and the 1956-57 registration was 1,982 students. The evening school consists largely of upgrading courses for employed persons and this year's enrolment was 5,200.

Ryerson maintains a close contact with the industrial and business world by means of advisory committees. These committees are composed of prominent individuals in various firms connected with the industries served. The members periodically review the technological curricula. They assist in securing scholarships and equipment, in establishing standards of attainment, and in organizing new courses to meet the needs of the industry concerned. Acting as liaison officers between the institute and the business and industrial world, they endeavour to interpret the work of the institute to industry and obtain support for it in a variety of ways. The number of scholarships and bursaries provided the students by various firms is a source of pride and satisfaction to the institute.

Ryerson is serving a wide field. Forty-five per cent of the enrolment is from Metropolitan Toronto, 49 per cent from provincial centres outside the boundaries of Metro, and six per cent from outside the province. It may be of interest to my listeners to know that this year there are enrolled at Ryerson 24 students from British Columbia, 13 from Alberta, 10 from Saskatchewan, 13 from Manitoba, 14 from Quebec, 13 from New Brunswick, seven from Nova Scotia, four from Newfoundland, one from the Yukon, and one from the Northwest Territories. Thus in its own way the institute is endeavouring to meet the need for trained personnel on both a provincial and national basis.

There are few people who do not recognize the problems for our country created by the shortage of engineering personnel. Satisfactory solutions will require careful planning and it is encouraging to note the steps that are being taken to rectify the situation. The present predicament was ably summarized by Dr. James R. Killian, President of the Massachusetts Institute of Technology, in a recent article:

> "The nation's technological work requires a broad spectrum of abilities and skills ranging from the technician, who does not need a degree, to the creative scientist or engineer whose education has carried him through the Ph.D. or even postdoctoral study. Men are in short supply throughout the entire spectrum but our greatest current shortages are at the extremes. We need more technicians to back up the professional scientist and more technical institutes to train them. At the other end of the spectrum, we need more graduate education and more graduate study opportunities to make this possible."

Most people will agree that this statement of Dr. Killian's mirrors the situation in Canada.

(viii) Universities' Needs

By Dr. C. T. Bissell,

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Any discussion of professional manpower arrives finally at the university. The reason for this is, I think, simple. The universities are, after all, one of the main sources from which we draw our professional manpower. Indeed, in our modern society, they are rapidly becoming the only major source, for virtually all the professions are, in various degrees, dependent on the university. In recent years we have seen a greater and greater concentration of professional training in the university.

Nursing, for instance, is an example in point. Although the preparation for nursing is still, in most cases, the sole responsibility of the hospitals, an increasing proportion of this preparation is now entrusted to the universities. One could mention other professions that have in recent years joined the university family: social work, physical and occupational therapy, and, in some sections of the country, law.

There is one basic question that we should try to answer at the very beginning. It is this. Is it right that the universities should be concerned in such a major fashion with the preparation of young men and women for professional careers? Is there not a necessary conflict between preparing the students for a specific profession and enlarging the mind through the medium of the traditional disciplines? Is there not a danger that the professional aim will demand an emphasis upon a narrow utilitarian point of view, upon certain specialized techniques, so that the university ignores its task of expanding the mind? Well, I don't think we are faced here with an inevitable conflict. After all, universities, from their earliest beginnings, have welcomed professionalism. The medieval European universities prepared for three major professions: law, medicine and the church. The modern university has simply added to the list. The real problem is not whether the university should have professional goals, but just how many separate professional goals it should try to sustain. I suppose the two major additions to the original three have been Engineering and Dentistry. And large universities have added many others: Forestry, Social Work, Library Work, Physical and Health Education, to mention only a few.

There are two points I should like to make here. If the university professional course becomes solely a training in technique and practice, then it can be done better and more economically elsewhere, in for instance, technical institutes. And if some universities refuse to accept additional professional courses, they should not be accused of shirking their proper work. There is after all a limit to the load they can bear, and their major responsibility is to provide instruction and to encourage research in the basic disciplines of the Humanities, the Social Sciences, and the Physical and Natural Sciences. If they fail in this, they fail in their major task; and they also fail in their responsibilities to the professions.

I think it is safe to assume, that all students at present in our universities who succeed in graduating will enter some sort of professional field. Some will go directly into their professional activities; others will take post-graduate work which in many cases is simply a form of professional training. Now, do we have a sufficient number of students in our universities to meet Canada's increasing needs for professional manpower? We now have in the neighbourhood of 75,000 students in our Canadian universities. Not all of these of course will graduate. The wastage will vary from 25 to 35 per cent. Certainly all those who graduate will be quickly absorbed into business, industry, government, the church, the school, and the universities themselves. In all professional areas—particularly in Engineering and in teaching at the three levels—the gap between what we have and what we need will be great. And this gap is likely to continue. What can we do to close this gap as quickly as possible?

I said a minute ago that the university population is now approximately 75,000. On the basis of some sober statistical analyses that total will double in ten years' time. At the present, we are drawing our student population from a potential reservoir of slightly over 900,000 students. These are the young men and women between the ages of 18 and 21. By 1965, the reservoir will have increased to 1,228,000, and it is also safe to assume that the proportion who go to university—now a little over seven per cent—will rise. As Canada becomes more and more urbanized, more and more boys and girls go to university. And as our society becomes more complex and technological, the cry for the expert, who is usually a university graduate, becomes increasingly clamorous.

Now, will natural forces look after the need for an expanded university population, and eventually solve our professional manpower shortage? Some experts are doubtful of this. At the recent conference on Scientific, Engineering, and Technical Manpower held at St. Andrew, some bold projections into the future were attempted. This conference came to the conclusion that if we were to graduate a sufficient number of engineers and scientific and technical personnel to look after the needs of our growing economy, and to maintain some sort of equality with the United States and Russia, we should have to increase our university population by the year 1980 until it reaches 375,000 or even 490,000, which, as you can see, even at the lower figure is five times the number of students we now have enrolled.

Well, whatever the factors involved, whether we think simply in terms of the natural increase in university population, or whether we think, more properly, in terms of our needs and what we should do to meet them, it is clear that the universities face a crisis such as they have never faced before.

Let me illustrate from a large provincial university, and from a small independent one. The University of British Columbia, in 1955-56, had 6,400 full-time students proceeding to a degree. In ten years' time, it is estimated that this student population will rise to, at a minimum, 14,000. Carleton University, the youngest of the Canadian universities, has a present full-time enrolment of 575. By 1965-66, this enrolment will be, simply on the basis of an increased student potential, 1,200. All across Canada we shall have similar population explosions in our universities.

Let me summarize my argument so far. First of all, the universities are the main sources of professional manpower. Second, they are now producing far fewer graduates than the economy of the country demands. Third, the

number will double simply by reason of natural increase, and may well go far beyond that by reason of social demands and technological urgencies. I come now to the fourth part of my argument. The universities, as at present constituted and financed, are in no position to receive and to train the flood of students who will be coming to them in the next few years and whom society dearly needs as graduates. What are the universities going to do about it? Or, to put the question in its more rational form, what is society going to do about it?

We might begin with the first question. What are the universities going to do about it? They could, of course, say—and with good reason—that they propose to maintain the *status quo;* that they have quite as many students now as they can handle; and that the only solution is to cut off applicants at shall we say the top 25 per cent, or whatever percentage is required to fill the available vacancies. But the universities are not taking this inflexible attitude. They are drawing up careful plans to meet the coming crisis in numbers. All across this country the universities have set up planning committees that are laboriously gathering facts and expressing them in terms of educational needs. Never, I think, in the history of education in Canada, have the universities been so keenly conscious of the future and of what they must do to prepare for it. I can assure you that Canada will not be weakened because of the failure of the universities to measure up to their responsibilities. Planning for the future involves two main areas. The first is the area of physical needs of classrooms, laboratories, offices, residences, heating plants; and the second and more important is the area of the human need which means, of course, more members of staff. Both areas present tangled problems. The physical equipment of universities has been allowed to fall behind even the needs of current enrolment, because, during the war there was a lag in building which has not yet been made up. All across Canada at the present time universities are resorting to bold, but unsatisfactory, improvisations to meet the crisis which is already creeping up on them. At my own University, for instance, we are trying to carry on the multiple activities in Arts, Science, Journalism, Public Administration, Commerce, and Engineering largely in a single building that was designed years ago as a small private school. The enormity of the task before them has not however induced in the universities Napoleonic designs. They are planning for simple, functional buildings that, without the sacrifice of the grace that should belong to halls of learning, will do the job in the most economical and efficient fashion.

Providing the buildings is not, however, the main problem. Bricks, mortar, steel already exist. But the human problem is less easily solved. At the present time, there are a little over 6,000 full-time members of academic staffs in all Canadian universities. And it is estimated that in order to meet the minimum needs during the next ten years, this staff should be increased in most divisions by as much as 100 per cent. Let us say that the minimum of staff required by 1965 is 10,000—and that is an estimate on the low side—an increase of approximately 4,000. This is a tremendous problem. Universities' staffs are not created overnight; they can't be secured by sending good prospects to colleges of education for a summer course. A member of a university staff must first of all take a long and rigorous post-graduate training before he even qualifies for the humblest lecturing post at a university. Unless these people are already in graduate schools, or will be going there immediately, then it is difficult to see where we will be getting our staff from. All we can do at the present time is to make sure that as

many as possible of our superior students are persuaded to go into graduate work, with the ultimate intention of preparing themselves for the academic profession. The problem here is, of course, to provide sufficient inducement for these prospective teachers. It is, I think, now widely known that the remuneration for university teaching is not excessive; indeed, the salaries of university teachers have fallen far behind the levels of comparable professions. It will become increasingly difficult to persuade young men and women to enter upon an academic career unless they have some assurance of an economic return that will enable them to play a full and effective role in society.

Inevitably, then, one comes down to finance. I do not want to suggest that the provision of adequate sums of money will adequately solve all university problems, but it will provide the basis for the eventual solution of most of them. And here we reach the second question that I put a few minutes ago.

What is society going to do about this problem? Because, as I must insist, the problem is basically society's. The universities, having taken careful forethought about the future, having stated their problems as comprehensively and as persuasively as possible, and having issued their warnings, must now await an adequate response from society. Is that response coming? I think there are some indications that it is, although as yet only a beginning has been made. The chief advances have come on governmental fronts. The Federal Government has doubled its grants to universities and has made available in the recent legislation for the Canada Council a sum of $50 million to be distributed to universities for capital needs in the Humanities and Social Sciences. Provincial governments across Canada are also awakening to their responsibilities and are shouldering their burden with varying degrees of alacrity. But I do not think that government action alone will be sufficient to give universities the strong, central position in our society that our cultural and economic health requires. Now this is not a depressing fact; it is rather a challenge and opportunity. It is a challenge and opportunity for the individual, whose own economic status is vastly improved by his attendance at university, and for business and industry, who, without university graduates, would not be able to survive. The strength of universities will not be assured by sporadic gifts for buildings and scholarships, no matter how generous; there must be continuous, regular, and unrestricted support so that university administrations are free to direct the funds to the places where they are most needed. More often than not the most effective use will be for more staff at better salaries.

I have in this talk taken, I fear, a rather business-like approach to the problem of professional manpower and the universities. I have reduced it to its simplest terms in order to bring home the crisis sharply. We must always remember that universities are, first of all, great intellectual and cultural centres; and only secondarily, the producers of professional manpower. But if that secondary purpose is adequately sustained and supported the universities will grow strong; and Canada will grow strong with them.

SECTION 3—INDUSTRIAL OPINIONS

(ix) Proper Use of Engineers

By W. F. McMullen,

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One of the many complex problems facing industry today, and one which will increase in difficulty over the next decade is that of the proper utilization of its varied manpower skills. Scientists, professional engineers, and engineering technicians of various levels of competence must be integrated into industry with a minimum of overlap and wasted effort.

The integration must make full use of the abilities of each, and provide challenge and stimulation for achievement for each one. This means that the work each one performs should provide him with a sense of purpose in that his work, whatever his level of competence, should appear to him and his company, to be important and significant.

Thus industry must establish clearly defined objectives, and from this develop an organization that will make the fullest possible use of the manpower available.

Once such objectives have been established, then the work to be done can be determined, and grouped within the organization structure in such a way that each position is clearly defined and the qualifications of the individual to fill such position become clear. This should eliminate overlaps and enable the individual to see clearly the scope and significance of his job.

Some industries in Canada find it relatively easy to obtain and develop technical manpower skills. An essential ingredient is what we call "climate". This "tone" or "atmosphere" in an organization not only will attract good men, but will enable them to develop faster and become more productive, and will also stimulate technical skills at all levels into further self-development.

I have been asked to discuss the question of the proper utilization of scientists, engineers and technicians, and their relationship with each other.

By definition, a scientist is "one devoted to systematized knowledge or scientific research", while the same source defines an engineer as "one who is skilled in the principles or practice of any branch of science".

Thus we see the definitions are remarkably similar, but in fact, in most instances the training is quite different. In Canada, scientists are usually developed through the honours courses in Physics, Chemistry, Mathematics, etc., with stress on the basic laws and fundamentals. Engineers graduate from engineering colleges with stress on these same laws and fundamentals too, *but* with the practical applications of such science to modern industry in mind.

This may appear to be an over-simplification, since many engineers continue their studies up to the doctorate level, and are engaged in basic research, whereas many scientists work in industry on the more practical applications of scientific research.

However, in Canadian industry, scientists are used primarily in the areas of development and research on new products and new processes, although almost half of the scientists in Canada are employed in education and government.

Engineers, and by this term I refer to professional engineers, who have either graduated from an accredited university in engineering, or been granted equivalent standing by a professional registering body, are used in a wide range of occupations in industry.

Engineers have long tended to function successfully in areas other than that for which they were specifically trained. The logical approach to problems, which is basic engineering training, has taken them out of the field of engineering design, into manufacturing, sales, management, patent law, government, and other areas. Some may argue that if engineers stuck to engineering there would be no manpower shortage, but in fact, engineering enters into so much of our complex modern industrial life, that there cannot be a clear distinction.

Some engineers may enter the executive, managerial, and government areas, and while their technical qualifications may not be fully utilized, nevertheless they are not wasted, since other abilities have come to the fore that have been developed by their engineering training. However, in any engineering design department there are different levels of jobs; *first* the creative and developmental which require the best talents of the professional engineer; *second,* those which require a good level of technical competence, but nevertheless are somewhat repetitive and involve working from established precedents; such are the jobs in which engineering technicians can make their great contribution; and then *thirdly*, there are the jobs of a clerical or routine calculating nature which can be handled by a clerical staff.

Historically, however, and a throw back from the days when competent engineers were plentiful and not too high priced, many gravitated into jobs in lower categories, and many remain still doing sub-professional work, which is frustrating, wasteful of manpower, and expensive.

There are many levels of technicians, and even here, no definition can be all-embracing. We can define an engineering technician as "one who can apply, in a responsible manner, proven techniques which are commonly understood by those who are expert in a branch of engineering, or those techniques specially prescribed by professional engineers".

The technician as generally understood works on engineering work but not on the level requiring the educational qualifications of the professional engineer.

In some industries, technicians perform as highly skilled trades, and as such can only be trained in that industry; one such example is the pulp and paper industry.

Others may conduct tests, experiments and other highly skilled manual work under the direction of a scientist or engineer. Such technicians must usually have sufficient technical competence to understand the reasons *for* and purposes *of* such operations.

In our own industry, electrical manufacturing, we find technicians working in the areas described above, but in addition, they have gone into our engineering function, where they are working on design and development problems along with professional engineers. The level of work assigned to them is limited only by their ability and technical competence. This has freed our engineers from much sub-professional work and has enabled them to handle more and effectively, the work of a more complex and creative nature.

Like the engineers, who are utilized in the areas of marketing and manufacturing as well as engineering, so the technicians have a real use here as well. Technicians are used in manufacturing areas on methods, time standards, processes, quality control, etc. In marketing they are capable of much semi-technical work and can even be used in sales engineering on products that do not really required a professional sales engineer.

What are the present sources of such technicians? This topic will be dealt with in more detail by other speakers, so I will confine myself to where industry can look for assistance other than recognized technical institutes.

As I mentioned earlier, certain classes of technicians can only be trained "in industry".

These normally come under the heading of apprenticeships and provide a means of training young high school graduates (usually from junior matriculation level) in the specific requirements of an industry. Each major industry has its own particular skills, and they can only be taught by practical "in-plant" training, amplified by some additional class room courses, arranged in conjunction with local educational institutions.

However, industry can also augment the numbers of technicians that are normally obtained from technical institutes and help itself by other means. By setting up more general industrial training internally and making full use of extramural activities such as night school classes, an additional source of technicians is available.

Such trainees may either be obtained directly from the high school graduating classes, of which, for a variety of reasons, many do not intend to continue their formal education; or from those who enter universities or technical institutes, and who drop out for financial, lack of interest, or other reasons; or from immigrants from European countries and the United Kingdom, where certain courses of study either at the National Certificate, or equivalent levels in Europe, enable them to fit in very well.

The introduction of Grade XIII (Technical) in the Province of Ontario, with its emphasis on English, Mathematics, Science, Economics, and Materials and Processes of Industry, will provide an incentive for many students to continue their technical education, and assist industry by providing a source of manpower with a higher level of competence and undoubted interest, who will progress rapidly once they gain practical experience.

We, in C.G.E. in our Peterborough Works, recently selected a number of promising students from district high schools and obtained the services of a competent instructor during the summer months to teach them the fundamentals of electricity. Over a period of eight weeks working about 40 hours a week, including lectures, plant visits, quizzes and a weekly examination, they completed their initial studies. They have been indentured as apprentices and are now on a rotational program within our plant, and are continuing their studies at night school on the advanced technical evening class work. At the end of four years they will have reached a certain level of competence and be classed as engineering technicians.

The proposal by the Association of Professional Engineers of Ontario for a system of registration of technicians under various grades, will provide incentive and encouragement for students entering this field to become ever more competent and to continue their development.

The probability of many technicians entering the profession of engineering by examination is also being stimulated. In our Company, in our Peterborough and Guelph plants, we have set up classes which will cover the bulk of examination requirements for professional registration.

By working with local educational institutions, and drawing instructors from our own staff, other local industries, and local schools and colleges, we can cover the required work in about five years, with three sessions per week, in evenings and Saturday mornings. Candidates must have certain minimum qualifications (normally senior matriculation) and as an added incentive we will refund all fees for successful examination results.

Industry has a continuing responsibility in assisting vocational guidance directors of our schools by "putting the case" clearly as to its needs; by participating in career days, arranging plant tours and visits, and helping community projects aimed at stimulating further education. Our motives should not be selfish, but guided by the principle that what is good for Canada, is good for industry. We must effectively use all our talents, and there is a place for everyone, if he or she is motivated and guided into a suitable career. Note that I said guided. I am convinced, that with proper encouragement, and example, we can overcome our current shortage of technical manpower, but it is going to require effort, and co-operation from everyone concerned.

(x) Role of Technician

By Richard Scott

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The first thing I want to say is that *you and I live in a world of tools.* What do I mean by this statement? You probably think of a tool as being a hammer, a chisel or a screwdriver. I wish to direct your attention for a few minutes to tools in a much larger sense of the word. For example, the radio to which you are listening is a tool by which you are able to hear my voice, which you certainly could not hear unless you were in the studio with me. The radio helps you to do something which you could not do otherwise. The skill required in using this tool at the moment is the ability to understand the words I am speaking.

Our tools help us to gain new and desirable objectives. Take another example. The chair which you may be sitting in, is a tool which helps you to write or to read without becoming fatigued. Your home in fact, is a tool which helps you to accomplish a multitude of things which you could not otherwise do. It gives you a comfortable place to play, eat, think and work. The refrigerator, the stove, the vacuum cleaner and the electric lights help you to reach your specific objectives. Your automobile is a tool which allows you rapid transportation from one place to another. Government agencies are set up to check your proficiency and to ensure that you are qualified to drive. When you *drive* you don't really *make* the car go, the *engine* drives the car but you direct it so that it does what you want it to do and does not disobey traffic regulations. You are the pilot and you require knowledge, judgment and skill.

The skill required in flying is more exacting than in driving an automobile, the knowledge required is greater, and the danger resulting from lack of judgment is critical. While our tools have progressed with science so that they require somewhat less manipulative skill in using them, the knowledge and judgment required have increased many times. The Wright Brothers who invented the airplane would be lost today flying by instruments in a jet at high altitude. On the other hand, the jet pilot would be risking his life if he stepped into the plane that was first flown at Kitty Hawk. The new tools of today make the skilled operator of yesterday look, act and feel like a helpless amateur.

These few examples of the uses of tools indicate that knowledge, judgment and skill are required by the user. Each one of us is a customer for many tools. At the same time, many Canadians produce tools for our so-called consumption. They in turn are using still other tools which are purchased in turn from suppliers who themselves were consumers of tools. At each stage, knowledge, skill and judgment brought the tools into being. *Truly, we live in a world of tools.*

The second thing I wish to bring to your attention is that *we are all technicians.* We *have* to be, to live in this modern world of ours. A technician is skilled in the technique of an art. He has to have the three things which I have already mentioned. To have the skill he must practice, to know the technique he must gain the knowledge, and to practice the art he must develop the judgment.

From the time that we are born, we are gaining knowledge and developing skill and judgment in using many tools which make our lives easier. The host of tools at our disposal, allows us to accomplish new things every day which our parents did not know were possible. However, we are faced with the problem as well as the opportunity of learning how to use these tools. An observer watching us trying to use new tools will think that we are very inefficient and unskilled technicians. By modern production methods we can manufacture tools at a very high rate indeed—in fact, far faster than we can develop technicians with the skills to use them. *This has resulted in Canada's present shortage of skilled technicians.*

There are many schools throughout Canada assisting young people to gain the skill, knowledge and judgment to fit them for a variety of technicians' jobs. However, to meet even part of the demand, employers have found it necessary to use a large number of immigrants. Canadian companies are sending representatives to England, Holland and other European countries to recruit the skill which they need to carry on their business. England has a well developed system of education in which four categories of people are trained. These are Tradesmen, Technicians, Technologists and Engineers. The arrangement permits the progressive development of individuals to respectively higher levels. In Canada, we do not have the proper proportion of educational facilities and therefore are not able to carry out this kind of a plan.

Engineers did technicians' work as well as engineering in 1900. Through research, a great deal of knowledge about our material world has been gained since that time. Consequently, the education of engineers has become more and more theoretical and will become even more so in the future. A great number of technicians are needed to implement the ideas of engineers. If we free engineers from routine work, they are able to proceed with the valuable development work which will raise our standards of living, so that you and I will enjoy more benefits in both our work and our leisure time. We have many new tools to release us from menial jobs and back-breaking labour. The responsibilities for each one of us are being upgraded physically, mentally, and ethically. We are all being elevated to new stations in life. We have moved away from the era of manpower into an era of skill-power and brain-power. In just three years 11 cents of every dollar spent will be for products not yet known to most of us. Right now, scientists and engineers are gaining knowledge of how to make these products practical and economical. If we started today to train technicians on these new products, we would only have three years to do it. Of course, in saying this, I am ignoring the fact that we do not know yet what training to give them, nor how many to train. Management must plan many years in advance for both the supply of the materials it requires and the development of the skilled manpower it needs. As yet, we are unskilful in knowing how to schedule training time to accomplish the desirable objectives we foresee. New tools must be found for forecasting the necessary lead-time for training. Apprenticeship has been and still is important in developing the manual skill of the tradesmen. However, manual skill is not as necessary for the technician as

knowledge and judgment. Knowing what to do and how to do it are important, but knowing why is becoming even more important. If we can answer the "why" satisfactorily, we can avoid fruitless activity.

If I asked you whether you were using your full capabilities in the job in which you are presently engaged, you would probably say NO. In fact, on the average we use only about 20 per cent of our potential and our potential grows as we grow. Here is a real problem for Canadian managers to solve. Our psychologists can make vast contributions in this area to Canadian development in the years to come. Vocational guidance counsellors will help too. However, when our industrial life is changing so quickly and training takes so long, guidance is needed today for 5, 10 or 15 years from now. As we become more specialized we become less adaptable to changes as they occur unless we keep learning. Therefore, continuing training becomes essential for us all throughout our lives.

Scientific research in the past 20 or 30 years has given a great wealth of new and exciting material things. However, our research has been lopsided. We have spent too little time, money and effort on educational research. We know comparatively little about how to develop people. Now, we are going to have to make the required expenditures. The first part of this century has been the era of scientific development. The second part will be the era of human development. I regret to say that research and development in this area are slow. However, the techniques and the tools we have developed in the scientific field will be useful suggestions in our approach to the problem. Suppose each person who has valuable knowledge and skill passed them along to another person and so in turn, our skilled manpower could be developed and multiplied at a phenomenal rate. By cascading learning with instructing, students could be allowed to teach what they have learned, so that their knowledge would be confirmed by conviction. Intimate communication could be achieved between the learner and instructor as is the case in what is called the tutorial method. By combining cascade education with co-operative education which is a plan of alternating work and study, I have great faith that a solution to our dilemma will be forthcoming. If our educational research is directed toward the development of a *graded career plan* in each major field of endeavour in Canada, we could work towards the goal of having everyone given the help needed to make a maximum contribution.

Education must be run as a business. It must be developed so that a maximum profit is produced for all concerned. Management must consider long-range perspectives in planning for the future, so that it neither counts on manpower that it will never have, nor overlooks the potentials of its current employees.

The Government must take a Canadian inventory of the available workforce and must develop techniques for indicating how it can best meet the nation's skill-power needs. The efficient utilization of our human potential is important in solving our manpower problem.

Just as you want value for your dollar when you go to the store, so management must demand value for the dollars it pays for the contributions of its employees. Only efficient productivity can increase the things we can buy. The shortage of efficient technical as well as other skilled manpower in Canada is a challenge for each one of us.

I would like to summarize for you the four suggestions which I have discussed with you in the past few minutes.

First: Management must make a diligent effort to plan for its manpower as well as to forecast its sales. It must strive to become more capable of utilizing the potential of its employees.

Second: Educational research must be expanded to exploit new methods and techniques in order that the inadequacies of present traditional education will be minimized.

Third: A national inventory of our skills must be established and maintained so that we can make the best use of our manpower.

Fourth: Each one of us must endeavour to meet the growing personal challenge and responsibility to raise our contributions to the level of our capabilities.

(xi) How Industry Can Help

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At the outset I feel we should ask ourselves to what extent industry is interested in professional manpower, for it seems logical that the degree of interest would have a marked bearing on the support and participation in the production of professional men that might be expected from industry.

During the past several months much has been said in the press and on the air about the shortage of scientists, engineers and technicians, or to use the all-inclusive term, the shortage of technical manpower. Last September a national conference of industrialists, educators, business, labor and government, was held at St. Andrews, New Brunswick, in order to discuss the extent of the shortage, the causes contributing to the shortage, and remedial action that could be taken to overcome the situation—not only in the immediate future, but for many years ahead.

As an outgrowth of this conference the Industrial Foundation on Education was established, financed by industry, as a fact-finding body and as an advisor to industry on educational matters. The Industrial Foundation on Education is a permanent body and has been working intensively since its formation last September.

Industry—and in referring to industry I mean specifically the manufacturing industries—is a large employer of scientists and engineers, but industry does not by any means employ the majority of these people as some groups would try to have us think. Canadian industry, in fact, employs about 44 per cent of the engineers and only 25.7 per cent of the scientists who are registered in Canada today.

Let's agree, however, that these are extremely important percentages and with the unprecedented technological advances made since the war, industry's requirements of scientists and engineers must, of necessity, increase.

To return, then, to my opening remarks, industry has established a means of obtaining expert advice on educational matters through the Industrial Foundation on Education, and as a major employer of technical manpower must, for its own progress and the well being of the hundreds of thousands of other people employed by industry, have an adequate flow of technical graduates from our universities and colleges. There can be no doubt that industry is vitally interested in education in all its aspects, because industry depends upon people. Our secondary schools, technical institutes and universities must produce an adequate flow of people to man and manage technical industry.

Let us now establish what we are talking about when we refer to professional manpower within the scope of this discussion. We mean not only the professional management people who are the administrators of modern business and who are skilled in the handling of men, money and machines.

The manufacturing industry makes use of professional people like the engineer, the lawyer, the accountant, the medical man, the scientist, the librarian, the researcher, the advertising specialist, the writer, the designer. All these are highly trained, skillful people.

They are the pilots of modern industry—without them our present economy could not exist.

This professional manpower is produced in a variety of ways. It is the product, first of all, of our educational system which is becoming more and more tuned to the needs of industry. There was a time not so many years ago when the universities produced only the teachers, the doctors, the lawyers, the writers and the pure scientists. Then modern technology required industry, and government, too, to provide opportunity for the pure scientist to grow into a research chemist or a physicist; and for the man who had learned English and languages at university to become an advertising writer. The mathematics student found scope for becoming a statistician or accountant.

In short, within the limit of their capabilities, the universities did a magnificent job in supplying the men and women needed in past years.

The only trouble is, they haven't done it fast enough in recent years—and for a very good reason.

Universities and educational institutions have been impoverished institutions since the days of medieval monks who founded them. They have never been able to collect enough money from students to pay their cost of operation and have always depended upon the contributions of patrons, and latterly industry and government, for their support.

Universities today consider that the maximum they can charge the student is 50 per cent of the cost of teaching him; the rest of the money has to come from somewhere else.

Industry has recently been attempting, in greater measure than ever before, to help take up this slack.

Some companies grant scholarships to the children of their own employees as does the Canadian Pacific Railways. Others have given large sums as grants in aid of university projects. Many are awarding annual scholarships and bursaries to enable people to go to university or to continue once they are there; and some, when granting scholarships, award a sum equal to the scholarship to the university.

Industry is also extending opportunities for higher education to key personnel by sending them to summer management training courses that the universities provide. Hundreds of young, and even not so young, management men, particularly in the middle management group are sent to the universities by their companies, their expenses and fees paid, and their salaries continued while they are away.

Many hundreds more are taking extramural training such as accountants studying for their CPA degree. Technical men are taking correspondence school courses; foremen are taking training courses to build them to the supervisory level, and so on.

The efforts which managements across Canada are putting into in-plant training and development of personnel is, in some companies, on the level of a university training course. An example of this is the Staff Training College of the Canadian National Railways.

More and more companies are engaging in continuous employee development programs such as the Bell Telephone Company with its employee development plan called "A Career for Every Man". Such plans cannot be covered the way they should be here, but briefly they are designed to develop the employees from the lowliest to the highest during their working lives. They help him to exploit his abilities to the greatest advantage for himself and the company, even going so far, in some cases, as to move him out of the company for further training in other industries in order to develop him.

And so the story may be unfolded with example after example to illustrate what industry has done and is doing to meet the professional manpower crisis.

But we know, at the same time, that we are losing good men through retirement policies made inflexible by the modern pension plan. Good men over 45 years of age are being lost because anybody hired after that age costs a good deal more for pension coverage. This same pension plan automatically kicks a man out of his company when he reaches pensionable age; and here again industry loses large numbers of well qualified, highly skilled, intelligent people who could make a worthy contribution to the company but are prevented by statistics from doing so.

In view of this, it is interesting to note that the First Ontario Conference on Aging is being held in Toronto May 31 to June 3. The Conference has two broad objectives—to find out what are the problems of aging in Ontario, and how solutions may be found for them; and to provide an opportunity for those working in this field to learn of each others' activities and discuss future co-operation.

In short, the subject will be thoroughly reviewed and I am confident much good will result from it. It is a problem which should not be incapable of solution although at the present time it is a knotty one indeed.

There is no single answer to the problem of producing professional manpower, of course.

They have been in short supply since the end of World War II, although the situation certainly has been aggravated by the country's unprecedented development.

We need not doubt that it is affecting our growth. Some companies have had to cut back plans for production and expansion as a result of the technical manpower shortage. Research and development have been curtailed. Some businesses fear that there will be a future shortage of executives.

What can we do to alleviate the situation in view of the survey recently conducted by the Department of Labour in Ottawa, which predicts, for example, that there will be need for an increase of 11.4 per cent a year in the number of engineers over the next few years, ranging from 6.5 per cent for mining engineers to 17.4 per cent for aeronautical engineers?

What can we do to solve the problem in view of the 50 per cent increase in requirements for professional people over the next 10 years; or some 200,000 people in actual numbers?

One thing is certain. We shall have to continue to do our part, as we have in the past, even if this contribution has sometimes gone unsung and unheralded.

The responsibility, of course, is not wholly ours. Government, too, has a major role to play in this time of crisis.

But we can help: By learning as accurately as we can what our present needs are, and what our requirements are likely to be.

By finding out what we have in the way of potential manpower and through helping to train technicians. Thus we can free professional manpower for jobs of greater importance in which their training will be used to greatest advantage.

By creating a climate of opinion, in which the wisdom of choosing a completed education will grow among high school students, many of whom in their haste to get out of school, cannot appreciate the need for further education.

By co-operating on a neighbourhood basis, especially in smaller communities and also within industries, by sharing men and know-how.

By making fuller use of our womanpower.

It is a major problem with which we are faced. Everyone is agreed on that point.

But Canadian industry, and the Canadian people have proved themselves adept at overcoming such problems in the past.

I am confident that this priceless Canadian characteristic, has not deserted us.

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
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